

## CLAIMS

1. A tool support, adapted in use to define an end-effector of an automated riveting machine, comprising at least two tool carrier arms,  
5 one of which is adapted to support a riveting tool, in which the tool carrier arms are movable relative to a fixed datum defined by the tool support.
2. A tool support as claimed in claim 1 in which the fixed datum is  
10 configured as a guide hole.
3. A tool support as claimed in any of the preceding claims in which one or more support members hold opposing ends of the tool support in a fixed spaced relationship.  
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4. A tool support as claimed in claim 3 in which opposing ends of the tool support are configured as end plates.
5. A tool support as claimed in claim 4 in which the guide hole is  
20 located in the end plate which is positioned closest to a workpiece when in use.
6. A tool support as claimed in any of claims 3 to 5 in which the support members are spaced around the guide hole.  
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7. A tool support as claimed in any of the preceding claims in which the carrier arm includes one or more bores.
8. A tool support as claimed in claim 7 in which a first bore in the  
30 carrier is used to mount the carrier arm on a support member, and a second bore in the carrier arm may accommodate a tool.

9. A tool support as claimed in claim 8 in which the carrier arm is movable to locate the second bore over the guide hole.
- 5 10. A tool support as claimed in any of claims 7 to 9 in which the carrier arm can pivot about the support member upon which it is mounted.
- 10 11. A tool support as claimed in any of the preceding claims in which the carrier arm is moveable by a ram and cylinder assembly.
12. A tool support as claimed in any of the preceding claims including a feed mechanism adapted to extend and retract a tool, accommodated in a carrier arm, into and out of the guide hole.
- 15 13. A tool support as claimed in claim 12 in which the feed mechanism comprises a plate suspended from a cylinder and ram assembly adapted to raise and lower the plate.
- 20 14. A tool support as claimed in claim 12 or claim 13 in which the feed mechanism is adapted to capture a tool accommodated in a carrier arm.
15. An end-effector for an automated riveting machine comprising a drilling tool, a sealant dispensing tool and a riveting tool.
- 25 16. An end-effector as claimed in claim 15 provided with a fixed datum with respect to which the tools are movable.
17. An end-effector as claimed in claim 16 in which the fixed datum is
- 30 configured as a guide hole.

18. An end-effector as claimed in claim 17 in which the tools are configured to operate through the guide hole
19. An end-effector as claimed in claim 17 or claim 18 in which the  
5 guide hole is located in the end of the end-effector which in use is positioned closest to a workpiece.
20. An end-effector as claimed in any of claims 15 to 19 in which the tools are movable between a resting position and an operating position.
- 10 21. An end-effector as claimed in any of claims 15 to 20 in which a tool is accommodated in a movable carrier arm.
22. An end-effector as claimed in any of claims 15 to 21 which  
15 includes three movable carrier arms, each carrier arm accommodating one tool.
23. An end-effector as claimed in any of claim 21 or claim 22 in which the carrier arm is mounted on a support member.
- 20 24. An end-effector as claimed in claim 23 in which the carrier arm can pivot about the support member upon which it is mounted.
- 25 25. An end-effector as claimed in any of claims 21 to 24 in which a cylinder and ram assembly moves the carrier arm.
26. An end-effector as claimed in any of claims 21 to 25 in which a carrier arm includes one or more bores.

27. An end-effector as claimed in claim 26 in which a first bore is used to mount the carrier arm on the support member and a second bore may accommodate a tool.
- 5 28. An end-effector as claimed in any of claims 17 to 27 which includes a feed mechanism adapted to extend a tool into the guide hole.
29. An end-effector as claimed in any of claims 17 to 28 in which includes a feed mechanism adapted to retract a tool from the guide hole.
- 10 30. An end-effector as claimed in any of claims 15 to 29 including a load cell
31. An end-effector as claimed in claim 30 in which the load cell is  
15 located on the end-effector at the interface with a robot.
32. An end-effector as claimed in claim 30 or claim 31 in which the load cell comprises a piezo ceramic cell.
- 20 33. An end-effector as claimed in any of claims 15 to 33 including a tool support as claimed in any of claims 1 to 14.
34. An automated riveting machine comprising a first end-effector and a second end-effector, the first end-effector carrying the tools, the second  
25 end-effector being positioned on the opposite side of a workpiece to, and in-line with, the first end-effector.
35. A machine as claimed in claim 34 in which the second end-effector comprises a clamping foot for clamping the workpiece.
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36. A machine as claimed in either claim 34 or claim 35 in which the second end-effector comprises a moveable reactor for upsetting a rivet stem.
- 5 37. A machine as claimed in any of claims 34 to 36 including a first end-effector according to any of claims 15 to 33.
- 10 38. A method of achieving a rivet connection in a workpiece comprising locating a first end-effector, with at least two tools one of which is a riveting tool, at a workpiece and positioning a second end-effector at the opposite side of the workpiece in-line with the first end-effector; sequentially moving each tool, in the first end-effector, arcuately from a resting position to an operating position above a guide hole in a lower end plate of the first end-effector, and operating each tool  
15 in turn through the guide hole to perform their desired operation.
39. A method as claimed in claim 38 in which a tool is configured as a sealant dispensing tool.
- 20 40. A method as claimed in claim 38 or claim 39 in which a tool is configured as a drill tool.